

REMARKS

Claims 12-44 are pending.

Claims 12 and 29 are independent claims.

Claims 12 and 29 are amended.

Applicants respectfully submit that the pending claims are patentable over the prior art.

I. CLAIM REJECTIONS 35 U.S.C. § 102(e)

Claims 12-25 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,985,762 (hereinafter "Geffken"). Applicants respectfully traverse this rejection.

Applicants respectfully submit Geffken does not appear to show all claim features of independent claim 12. However, solely to expedite prosecution, Applicants have amended independent claim 12 to recite, among other things, "etching the first portion of the diffusion barrier at the bottom of a via while depositing a second portion of the diffusion barrier, other than the etched first portion, elsewhere on the substrate (emphasis added)." This amendment has been made to make explicit what was implicit and is not meant to narrow the scope of the claims.

The present invention, as embodied by independent claim 12, provides for the deposition of a first portion of a diffusion barrier followed by the separate step of simultaneous etching of the first portion and deposition of a second portion (which is not the first portion). Applicants describe a specific, non-limiting example of this in Applicants' Specification at Page 14, line 33 to Page 15, line 10. Here, Applicants show how a first

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copper oxide layer (third aspect). Simultaneous deposition/sputter-etching may be performed within a high density plasma (HDP) sputtering chamber by adjusting the chamber's RF coil power and RF wafer bias to achieve the  
5 desired deposition/sputter-etching ratio. Alternatively, deposition of the barrier layer and sputter-etching of the copper oxide layer and the capping dielectric barrier layer may be performed "sequentially" within the same chamber or  
10 by depositing the barrier layer within a first processing chamber (e.g., an HDP chamber) and by sputter-etching any copper oxide layer and any capping dielectric barrier layer within a separate processing chamber (e.g., a sputter-etching chamber such as Applied Materials' Preclean II chamber). In either case, deposition of the second copper  
15 layer preferably is performed prior to breaking vacuum so as to maintain a copper-oxide free interface between the first and second copper layers.

Other objects, features and advantages of the present invention will become more fully apparent from the  
20 following detailed description of the preferred embodiments, the appended claims and the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-<sup>1</sup>~~C~~ are sequential cross sectional views of  
25 the formation of a conventional copper interconnect as previously described;

FIG. 2 is a diagrammatic illustration, in section, of the pertinent portions of an high density plasma sputtering chamber for practicing the present invention;

30 FIGS. 3A-<sup>3</sup>~~C~~ are sequential cross sectional views of the formation of a copper interconnect in accordance with a first aspect of the present invention;

FIGS. 4A-<sup>4</sup>~~D~~ are sequential cross sectional views of the formation of a copper interconnect in accordance with a  
35 second aspect of the present invention;

5  
FIGS. 5A-~~C~~<sup>5</sup> are sequential cross sectional views of the formation of a copper interconnect in accordance with a third aspect of the present invention;

FIG. 6 is a top plan view of an automated  
5 semiconductor manufacturing tool useful for performing the inventive methods;

FIG. 7 is a flowchart of the operation, in  
pertinent part, of the automated semiconductor manufacturing  
tool of FIG. 6 as controlled by a controller during the  
10 formation of the inventive interconnects of FIGS. 3A-5C;

FIG. 8 is a flow chart of a first interconnect  
subroutine of the flow chart of FIG. 7;

FIG. 9 is a flow chart of a second interconnect  
subroutine of the flow chart of FIG. 7; and

15 FIG. 10 is a flow chart of a third interconnect  
subroutine of the flow chart of FIG. 7.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the preferred aspects of the present invention,  
20 copper interconnect formation is performed primarily within  
a high density plasma sputtering chamber (although  
interconnect vias may be filled by a process for filling  
vias, such as chemical vapor deposition (CVD), physical  
vapor deposition (PVD) or electroplating as is known in the  
25 art). Accordingly, before discussing the preferred aspects  
for copper interconnect formation, the operation of such a  
high density plasma sputtering chamber is described briefly  
with reference to FIG. 2.

FIG. 2 is a side diagrammatic illustration, in  
30 section, of the pertinent portions of a high density plasma  
sputtering chamber 21 for practicing the present invention.  
The sputtering chamber 21 contains a wire coil 23 which is  
operatively coupled to a first RF power supply 25. The wire  
coil 23 may comprise a plurality of coils, a single turn  
35 coil as shown in FIG. 2, a single turn material strip, or